$\frac{2}{3}$–$\frac{3}{4}$ the distance between the origins of the dorsal fins and as long as the longest rays of the second dorsal. Pectoral $\frac{2}{3}$ the length of head, extending to or a little beyond the vertical from the origin of spinous dorsal.

Hab. Guatemala, Rio Guacalate (*Salvin*).

Total length 210 mm.

7. *Agonostomus Salvini.*

D. IV, I 8. A. II 10. Sc. 38–40. Closely allied to *A. nasutus*, but upper lip not so thick, eye smaller, lower jaw a little longer, pectoral fin shorter. Maxillary extending to below anterior $\frac{1}{4}$ or $\frac{1}{3}$ of eye. Dorsal spines moderate, the first $\frac{2}{5}$ (adult) or $\frac{1}{2}$ (young) the length of head or of the distance between the origins of the dorsals. Pectoral $\frac{2}{3}$ the length of head or less, not extending to below the spinous dorsal.

Hab. Guatemala, Rio Nacasil (*Salvin*).

Total length 270 mm.

VII.—*A Contribution towards a Knowledge of the Entozoa of British Marine Fishes.*—Part I. By William Nicoll, M.A., B.Sc., Gatty Marine Laboratory, St. Andrews.

[Plates I.–IV.]

The following account of an as yet little-known province of British marine zoology can hardly be regarded as more than a mere preliminary. The original intention was to have treated the subject in a systematic manner, dealing with the Entozoa of each of the natural groups of fishes—Gadidæ, Pleuronectidæ, &c.—separately; but as this was found impossible for the time being, the most satisfactory remaining course seemed to be to study the easily accessible fishes as they came to hand. It will be seen that these fall under two classes: (1) the commoner littoral fishes, gunnel, stickleback, &c.; (2) the commoner food-fishes, haddock, dab, &c. A large number of each species, except in a few instances, having been examined, the results obtained may be regarded as fairly accurate and the parasites from each host as comparatively typical. Special attention has been devoted to the Trematode forms; cestodes occurred but rarely, except in the form of scolices. Nematodes and Acanthocephala were frequent, but, for the most part, assignable to common species. Several forms remain unnamed, mostly young Ascarids, which are difficult to diagnose.

No Elasmobranch fishes are noted in this paper, and of the Teleostei, three groups—Pharyngognathi, Lophobranchii, and Pleetognathi—are unrepresented. Of the remaining three groups upwards of 60 species are recorded from St. Andrews Bay, but only 50 of these are at all common. About half of these are dealt with here. A few yielded no parasites, a notable case being *Blennius pholis*, which will be referred to later; amongst the others an individual not harbouring its quota of parasites was exceptional.

A striking feature of the herein-noted results is the large number of instances in which a parasite is recorded from a new host, although the new species are few. This may be due to a particular host not having been examined before or to its not having harboured Entozoa in the localities where it had previously been examined. A third possibility suggesting itself is that two species of fish may have been confused or regarded as identical, and the parasites of one attributed to the other. A case in point is that of *Cottus scorpius*, Bloch, and *C. bubalis*, Euphr., between which I have sometimes found difficulty in deciding. I have, however, carefully compared each specimen examined with Day's descriptions of the two species, and in so far as he is to be depended upon the results may be regarded as correct. The large number of forms new to *Cottus bubalis* may be explained in this way; moreover, almost every one occurred in an example which was unmistakably *Cottus bubalis*, Euphr.

This leads us to a consideration of the work of previous observers. Two most important attempts have been made towards a systematic and exhaustive knowledge of the Entozoa of the North Sea fishes—the one by Olsson * in 1867, the other by P. J. van Beneden † in 1870. The work of the former was done in the waters off the west coast of Norway, which can hardly be regarded, strictly speaking, as the North Sea; but since the majority of the species which he examined are common to our shores, we can include his results under those for fish taken within the North Sea. Van Beneden deals with fish from the Belgian coast and from further out at sea. Both examined a very large number of fishes, especially the commoner varieties. Amongst the littoral fishes neither Olsson nor Van Beneden makes mention of *Gobius Ruthensparri* and *Liparis Montagui*. Olsson, in addition, omits *Zoarces viviparus*; Van Beneden, *Cottus*

* "Entozoa hos Skandinaviska hafsfiskar," Lunds Univ. Årsskrift, vol. iv. 1867, no. viii.

† "Les Poissons des Cotes de Belgique," Mem. Acad. Belg. xxxviii. 1871.

bubalis. From their observations no parasite appears to infest the fish haunting the pools and crevices along the shore in the same way as *Podocotyle atomon*, Rud., has been found to do at St. Andrews. The presence of this Trematode is quite a feature; it occurs in eight out of the nine species examined. Another common form is *Echinorhynchus acus*, Rud., which was found in four species. Amongst the fishes from deeper waters the widely-spread *Hemiurus* forms and *Derogenes varicus*, Müller, are recorded very frequently by both the above-mentioned observers. As might have been expected, the same is true in the present instance.

Fish, such as the herring and haddock, which roam far and wide in their search after food tend to exhibit the same parasitic fauna in whatever quarter they are taken, but the littoral fish, with their more circumscribed lives, are dependent on local faunæ for food, and in consequence their parasites vary according to the locality.

A case like that of *Podocotyle atomon*, Rud., would almost lead one to enunciate the hypothesis that the Entozoa of a particular fish depend more on its environment than on the species to which it belongs; that is to say, that no matter what the species of fish the parasites found in it ought to be the same as those found in other species from the same neighbourhood. This raises the very important question of idiosyncrasies in feeding, for it is well known that different species, although living quite close together, have often entirely different modes of feeding. Van Beneden took some pains to note the food of the various fish which he examined; but into this matter I do not propose at present to enter. One case, however, that of the shanny, *Blennius pholis*, cannot be overlooked. It occurs here commonly, and I had an opportunity of examining a large number, but in no instance did a single parasite present itself. Such a fact is not remarkable in itself, but, in view of the frequency with which other fish in the vicinity were infected, it is striking enough. Van Beneden found the food of the shanny to consist of crustaceans, *Balanus* for the most part. In addition to crustaceans I have met with excessive numbers of small gastropods, especially young *Littorina*. Thus the food is apparently not so very different from that of other species. The presence of the large number of shells in the intestine might be offered as a reason for the absence of parasites, but shells and other hard débris are found in fish in which parasites abound. Another explanation might be sought in some constitutional peculiarity of the shanny which renders it an unsuitable host. Similar instances—e. g. *Agonus*

(*Aspidophorus*) *cataphractus*, *Ctenolabrus rupestris*, and *Brosmius brosme*—occur in Olsson's observations, although he makes no comment upon them.

Neither Olsson nor Van Beneden made any attempt towards a solution of the life-history of the forms with which they deal. The subject is difficult and requires special and long continued study. Levinsen * made an extensive search amongst the marine Invertebrata of Greenland for intermediate forms, and was successful in three or four cases. His results have not been confirmed. Latterly some important work has been done in this direction by Miss Lebour in Northumberland †. She has investigated many of the commoner Mollusca and has recorded from them quite a number of sporocysts and cercariæ. The difficulty of tracing these to their final host still remains.

In the Irish Sea at the Liverpool Laboratory considerable additions have been made to the British Entozoa fauna by Johnstone ‡. Very few Trematodes are mentioned, Cestodes receiving most attention. His note on *Distomum valdemflatum*, Stoss., is interesting and will be referred to later. The occurrence of *Hemiurus appendiculatus* in very small ($\frac{1}{2}$–1 in.) plaice and dabs is curious, for this Trematode has never been recorded from these fish in their adult state. The mention of a form (*Distomum gulosum*, Linton) first described from America is also noteworthy. Linton's work on the American fishes § reveals many forms which are the same as or almost identical with species already known from corresponding European fish. He himself is unable in several cases to establish their identity with absolute certainty. His work is valuable on account of the care with which he has studied and measured the various important organs, but unfortunately little exact information is to be derived from his plates.

Some experiments which I had an opportunity of conducting with sticklebacks may conveniently be described here. The fact that the sticklebacks from brackish ditches were infected with *Podocotyle atomon*, Rud., to as great an extent as those from the marine rock-pools suggested ascertaining the effect

* "Bidrag til Kundskab om Grönlands Trematodfauna," Oversigt Kgl. Dansk. Selskab. 1881, pp. 52–84, pls. ii., iii.

† "Notes on Northumbrian Trematodes," Northumberland Fisheries Report for 1905.

‡ "Internal Parasites and Diseased Conditions of Fishes," Lancashire Sea-Fisheries Report for 1904, p. 98; 1905, p. 151.

§ Proc. U.S. Nat. Mus. xx. pp. 423–456, pls. xxvii.–xxxiv. and pp. 507–548, pls. xl.–liv.

of pure fresh water. Some examples, both from pools and from ditches, were confined in a tank of fresh water. For two months they were supplied with pond-weeds, snails, grubs, &c., which, however, they did not accept very readily. At the end of that time some were examined and found to contain the parasites as frequently as before. No new parasites had made their appearance. For another two months the sticklebacks received no food at all, and on examination thereafter no diminution in the number of parasites was observable, although by this time the fish were in a very poor condition. This is at variance with the observations of Zschokke and others, who found that in fish migrating from the sea to rivers the parasites acquired during their sojourn in the sea were gradually killed off by the fresh water of the river. The above experiment appears to indicate that the disappearance of the parasites in certain cases is not wholly attributable to the effect of the fresh water, but that some other factor must enter into account. The length of time (four months) during which the fish were confined to the fresh water was ample for any effect due to the water to have taken place. The only noteworthy circumstance observed was the largely increased number of ova extruded from the parasite in the intestine of the host.

The following is a list of the hosts examined, with their respective parasites; the habitat is also noted. An asterisk prefixed to the habitat denotes that the parasite is recorded for the first time from this situation; an asterisk prefixed to the name of the parasite denotes that it is here recorded for the first time from this host. The fish are named according to Day's 'British Fishes.'

ACANTHOPTERYGII.

Gasterosteus aculeatus, Linn. 3-spined Stickleback.	
Podocotyle atomon, *Rud.* (= Psilostomum redactum, *mihi.*)	Stomach, intestine.
*Ascaris sp. (juven.).	Body-cavity.
Cottus scorpius, Bloch. Bullhead.	
Podocotyle atomon, *Rud.* (=Distomum simplex, *Rud.*)	Intestine.
Derogenes varicus, *Müller.*	Stomach and *intestine.
Distomum sp.	Gills in capsules.
Echinorhynchus acus, *Rud.*	Intestine.
Bothriocephalus punctatus, *Rud.*	Intestine.
Cottus bubalis, Euphr. Father-lasher.	
Podocotyle atomon, *Rud.*	Intestine.
*Hemiurus appendiculatus, *Rud.*	Stomach.
*Derogenes varicus, *Müller.*	Stomach.
*Prosorhynchus squamatus, *Odhner.*	Intestine and pyloric appendages.

*Ascaris sp.	Body-cavity.
*Ascaris capsularia, *Rud.*	Peritoneum.
*Ascaropsis morrhuæ, *v. Ben.*	Intestine.
*Echinorhynchus acus, *Rud.*	Intestine.
Bothriocephalus punctatus, *Rud.*	Intestine.
*Scolex polymorphus, *Rud.*	Intestine and rectum.
*Distomum sp. (juven.).	Skin, muscles, &c., in capsules.

Gobius Ruthensparri, Euphr. Double-spotted Goby.

*Podocotyle atomon, *Rud.*	Stomach and intestine.
*Distomum sp. (juven.).	Gills in capsules.
*Ascaris sp. (juven.).	Body-cavity.
*Scolex polymorphus, *Rud.*	Intestine.

Cyclopterus lumpus, Linn. Lump-sucker.

Scolex polymorphus, *Rud.*	*Stomach and intestine.

Liparis Montagui, Donov. Montague's Sucker.

*Podocotyle atomon, *Rud.*	Intestine.
*Prosorhynchus squamatus, *Odhner.*	Intestine and pyloric appendages.
*Echinorhynchus acus, *Rud.*	Intestine.
*Ascaris sp. (juven.).	Body-cavity.

Centronotus gunnellus, Linn. Gunnel.

*Podocotyle atomon, *Rud.*	Intestine and rectum.
*Hemiurus appendiculatus, *Rud.*	Intestine.
*Ascaris sp. (juven.).	Peritoneum.

Zoarces viviparus, Linn. Viviparous Blenny.

*Podocotyle atomon, *Rud.*	Intestine.
*Echinorhynchus acus, *Rud.*	Intestine.

ANACANTHINI.

Gadus æglefinus, Linn. Haddock.

Lepodora rachiæa, *Cobbold.*	Intestine.
*Hemiurus communis, *Odhner.*	Stomach.
Ascaris communis, *Dies.*	*Body-cavity.
Ascaris clavata, *Rud.*	*Stomach.
*Ascaris sp.	Intestine.
*Agamonema commune, *Dies.*	Liver and pyloric appendages in capsules.
*Heterakis foveolata, *Rud.*	Intestine.
*Ascaropsis morrhuæ, *v. Ben.*	Mouth, œsophagus, stomach, intestine.
Echinorhynchus acus, *Rud.*	Intestine.
Bothriocephalus rugosus, *Rud.*	Intestine and pyloric appendages.
*Scolex polymorphus, *Rud.*	Intestine.
*Scolex sp.	Gall-bladder.

Gadus merlangus, Linn. Whiting.

Derogenes varicus, *Müller.*	*Intestine.
Ascaris clavata, *Rud.*	Intestine.
Filaria echinata, *v. Linstow.*	Intestine.

Motella mustela, Linn. Five-bearded Rockling.

*Podocotyle atomon, *Rud.*	Stomach and intestine.
Ascaris capsularia, *Rud.*	Peritoneum.

Ammodytes tobianus, Linn. Sand-Eel.

*Hemiurus communis, *Odhner.*	Œsophagus, stomach, intestine.

Brachyphallus crenatus, *Rud.*	Stomach and intestine.
Lecithaster gibbosus, *Rud.*	Intestine.
*Ascaris sp. (juven.).	Body-cavity.
*Ascaris sp.	Intestine.
*Echinorhynchus acus, *Rud.*	Intestine.
(?) Scolex ammodytis Tobiani, *v. Ben.*	Intestine.
Hippoglossus vulgaris, Flem. Halibut.	
*Stephanochasmus baccatus, sp. n.	Rectum.
*Hemiurus appendiculatus, *Rud.*	Stomach.
Derogenes varicus, *Müller.*	Stomach.
*Derogenes cacozelus, sp. n.	Intestine and rectum.
Ascaris capsularia, *Rud.*	Peritoneum.
Ascaris collaris, *Rud.*	Intestine.
*Ascaris sp.	Rectum.
*Ascaropsis morrhuæ, *v. Ben.*	Stomach.
*Filaria echinata, *v. Linstow.*	Rectum.
Heterakis foveolata, *Rud.*	Stomach.
Scolex polymorphus, *Rud.*	Intestine and *rectum.
Rhombus maximus, Linn. Turbot.	
*Zoogonoides viviparus, *Olsson.*	Rectum.
*Derogenes varicus, *Müller.*	Mouth, œsophagus, and stomach.
Bothriocephalus punctatus, *Rud.*	Intestine.
Scolex polymorphus, *Rud.*	Intestine.
Rhombus lævis, Rondelet. Brill.	
Derogenes varicus, *Müller.*	*Stomach.
*Ascaris collaris, *Rud.*	Intestine.
Pleuronectes limanda, Linn. Dab.	
Zoogonoides viviparus, *Olsson.*	Intestine and rectum.
Steringophorus furciger, *Olsson.*	Stomach and intestine.
*Derogenes varicus, *Müller.*	Mouth, œsophagus, and stomach.
*Derogenes cacozelus, sp. n.	Intestine.
Ascaris capsularia, *Rud.*	Peritoneum.
*Ascaris sp.	Intestine and pyloric appendages.
Scolex polymorphus.	Intestine.
Pleuronectes platessa, Linn. Plaice.	
Zoogonoides viviparus, *Olsson.*	Intestine and rectum.
Heterakis foveolata, *Rud.*	Intestine.
Scolex polymorphus, *Rud.*	Intestine.
Pleuronectes microcephalus, Flem. Lemon-dab.	
Distomum sp.	Intestine.
*Ascaris sp.	Intestine.
*Ascaropsis (?) sp. (juven.).	Intestine.

Physostomi.

Clupea harengus, Linn. Herring.	
*Hemiurus Lühei, *Odhner.*	Stomach and cæcum.
Agamonema capsularia, *Dies.*	Peritoneum.
Anguilla vulgaris, Turt. Eel.	
Hemiurus appendiculatus, *Rud.*	Stomach.
Lecithochirium rufoviride, *Rud.*	Stomach.
*Scolex polymorphus, *Rud.*	Intestine.

Trematoda.

Podocotyle atomon, Rud. (Pl. I. figs. 1, 2.)

Distoma simplex, Rud. ?, Olsson, Levinsen, Grönlands Trematodfauna, p. 8, pl. iii. fig. 1.

Allocreadium atomon (Rud.), Odhner, Zool. Jahrb. Syst. xiv. p. 506, pl. 33. figs. 9, 10.

Podocotyle atomon (Rud.), Odhner, Fauna Arctica, iv. (2) p. 320, pl. ii. figs. 9, 10.

Psilostomum reductum, sp. n., Nicoll, Ann. & Mag. Nat. Hist. (7) xvii. p. 525, pl. xiii. figs. 9, 10.

This is a species which Odhner regards as wrongly identified by Olsson *, although the latter had some doubt on the matter himself. Olsson assigned his specimens to *Distoma simplex*, Rud., and was followed by Levinsen and Linton. Odhner, by elucidating the structure of *Distomum atomon*, Rud., shows that they ought really to have been assigned to this species. He also includes *Distomum reflexum*, Creplin, under this species, although he excludes the forms which Olsson † and Zschokke ‡ identified as such. As *Psilostomum reductum* I described what I considered to be a distinct species, but I must now regard it as identical with *Podocotyle atomon*, Rud.

Of Rudolphi's *Distoma simplex* (= *Fasciola aglefini*, Müller) no specimens remain, so that Odhner regards the species as unidentifiable. He omits notice of the fact that Van Beneden § found in *Gadus æglefinus* what he apparently regarded as *Distomum æglefini*, Müller. Van Beneden is slightly confusing, for while he marks the form "*sp. nov.*" in his notes, without any attempt at description, the accompanying figure is marked *D. aglefini*, Müller, and we may suppose that this was his real intention. Von Linstow ‖ notes both *D. simplex*, Rud., and *D. aglefini*, van Beneden, under *Gadus æglefinus*, so that he was either misled by van Beneden or he regarded the two species as distinct. Stossich ¶ falls into the same error. Van Beneden's figure is meagre, but, so far as it goes, exhibits a certain resemblance to the form we are here dealing with. The large elliptical ventral sucker, the position of the genital aperture, the male genital

* "Entozoa iaktt hos Skandinaviska hafsfiskar," in Lunds Univ. Arsskrift, iv. p. 34, pl. iv. figs. 81, 82.

† Lunds Univ. Arsskrift, iv. (8) p. 52.

‡ Verhandl. Gesell. Basel, Thl. 8, Hft. 3, p. 789, pl. xi. fig. 1.

§ "Poissons des Côtes de Belgique," p. 56, pl. iv. fig. 14, in Mém. Acad. Roy. Belg. xxxviii.

‖ Compend. d. Helminthol. p. 236.

¶ Dist. d. Pesci, p. 61.

apparatus, the vitelline glands, testes, and ova, all point to its being a member of the genus *Allocreadium*. The ova are excessively large and the ovary is absent, and on this account it is impossible to assign this form to any of the already known members of the genus, so that the difficulty of proving the identity of *Dist. simplex*, Rud., still remains.

Olsson found this parasite occurring in *Sebastes norvegicus* (one or two fairly often), *Gadus melanostomus* (frequently numerous), *Raniceps niger* (once, in great numbers), *Anguilla vulgaris* (a single specimen). Levinsen found it fairly often in *Cottus scorpius* and *Cottus gobio* (*Phobetor ventralis*) from Greenland. Rudolphi's specimens were from the stomach of *Pleuronectes flesus*. Odhner adds that he "has met with it in a very considerable number of other Scandinavian marine fishes from the west coast of Sweden," although I have seen no list of such forms. I have already recorded it from *Gasterosteus aculeatus* (var. *trachurus*), and to this I have to add *Cottus bubalis*, *Cottus scorpius*, *Gobius Ruthensparri*, *Centronotus gunnellus*, *Zoarces viviparus*, *Motella mustela*, and *Liparis Montagui*. About 70 per cent. of the total number of fish of these species examined were infected, usually with three or more adult parasites and often a large number of young. Thus it may be understood that this form is exceedingly frequent.

Olsson determines the length of his specimens at 3–9 mm.; Levinsen found somewhat smaller examples in *Cottus scorpius* (3–5 mm.); Odhner gives the average length as about 2 mm., and is inclined to regard Olsson's larger specimens as a variety. He also differentiates a medium-sized variety corresponding with Levinsen's specimens and also with *Dist. reflexum*, Crepl. My examples only in rare cases exceed 3 mm., the majority being 1·5–2·5 mm., so that as far as length is concerned they correspond with Odhner's smallest variety, *i. e.* with the Rudolphi type. Fully developed adults were found as small as 1 mm.; one small example from the stickleback measured 1·01 mm., and contained seven ova measuring ·081 × ·047 mm., *i. e.* of fully normal size. The largest immature individual observed was ·90 mm. in length; it contained no ova, but the penis was well developed, and the testes were as large as ·28 × ·11 mm.

The general shape of the body is elongate-ovoid, depressed, somewhat attenuate anteriorly, more rounded posteriorly. Like the other species of the genus, it is extremely mobile, the ant-acetabular region being capable of great extension and contraction, the post-acetabular part less so, but the

cuticle of the latter is often thrown into irregular wrinkles. The constriction at the level of the testes, noted by Olsson, is not of invariable occurrence, and the outline of preserved (pressed) specimens is comparatively even. The colour viewed by transmitted light is greenish yellow, darker posteriorly from the presence of the yolk-glands and golden yellow centrally from the ova.

The cuticle is of no great thickness, devoid of spines, and striated longitudinally and transversely. The suckers are fairly well developed: the oral sucker is subterminal and globular, with a circular aperture; its diameter is usually about $\frac{1}{10}$ of the length of the body, but it is proportionately larger in the younger examples than in the older, the observed limits being ·12 mm. in the smaller (1·0 mm.) and ·29 mm. in the largest (3·15 mm.). The ventral sucker is more variable; it is always elliptical in outline, with a corresponding aperture, the long axis being transverse and usually about half as long again as the diameter of the oral sucker, *i. e.* $\frac{1}{4}$ of the total body-length, but here again the proportion decreases with increase in size. The measured dimensions were ·22–·42 mm. These figures agree very closely with those of Odhner, viz. ·12–·25 mm. for the oral and ·25–·44 mm. for the ventral sucker. Linton's American specimens yield pretty much the same figures.

Another feature to which some importance is attached is the distance between the suckers (*i. e.* length of neck). My observations coincide with those of Levinsen, viz. $\frac{1}{5}$–$\frac{1}{4}$ of the length of the body and $\frac{1}{3}$ in young individuals. Odhner also determines the limits at $\frac{1}{5}$–$\frac{1}{3}$.

The alimentary system conforms to the genus type, except that a distinct prepharynx is present, first noted by Odhner. It appears as a dilated tube about half as long as the pharynx and considerably wider than the œsophagus. The pharynx is almost globular, with a diameter of about ·10 mm., but its breadth usually exceeds its length slightly. The œsophagus may be twice as long as the pharynx, but on contraction it is bent in the form of an S, and appears short then. The bending takes place either laterally or dorso-ventrally.

The excretory vesicle is a long simple closed sac extending as far forward as the level of the ovary, and opening posteriorly by a terminal pore. To it run down two narrow convoluted tubules, one on either side.

The genital aperture lies almost midway between the two suckers and also midway between the median line and the extreme left edge of the body. It is thus to the left of the œsophagus and between the pharynx and intestinal

bifurcation. The cirrus-pouch is long and narrow, extending some distance behind the ventral sucker. It contains at its posterior end a large bipartite vesicula seminalis, from the anterior end of which issues the ductus ejaculatorius. The latter bends back almost immediately to lie alongside the vesicula seminalis, but bending again it passes forward to the penis. This organ is long and slender, and when well extended is curved. It has a squarely-cut end, but instead of being inflated at its termination, as Olsson represents it, it is somewhat tapering. The configuration of the internal genitalia is precisely as Odhner* represents it.

In one case I was fortunate enough to witness the fertilization and formation of the ova. The worm was under pressure, and the unfertilized ova passed along the oviduct fairly rapidly. As each arrived opposite the receptaculum seminis, it was surrounded by sperms, and shortly afterwards two or three yolk-plugs were congregated round it. The mass was forced on towards the uterus, receiving as it went a shell-coating and gradually acquiring the characteristic elliptical shape. The whole process did not last longer than ten minutes.

The vitelline glands consist of numerous follicles, not by any means so regular or so large as Odhner represents them. He is correct in saying that they do not extend in front of the ventral sucker, although occasionally a follicle or two is to be found in the neck.

The uterus is short and rarely contains more than 20–40 eggs; Odhner says 20–30, and yet in his figure † he represents upwards of 80 eggs. The ova are light yellow to yellowish brown in colour, and measure, according to my observations, ·075–·084 mm. in length by ·040–·054 mm. in breadth. These rather wide limits include measurements of the ova from various hosts. The details in four cases are as follows:—

	mm.	mm.
From *Gasterosteus aculeatus*	·075–·081	× ·040–·044
„ *Cottus bubalis*	·075–·081	× ·044–·054
„ *Centronotus gunnellus*	·075	× ·050–·052
„ *Zoarces viviparus*	·081–·084	× ·046–·050

Odhner's figures are ·060–·084 mm. × ·040–·045 mm. The minimum length-limit seems rather small. I have certainly never observed ova (mature, at least) approaching that small size. My measurements were usually determined

* *Loc. cit.* pp. 510–511, pl. 33. fig. 10.
† *Loc. cit.* pl. 33. fig. 9.

from ova as near the terminal portion of the uterus as possible. Linton's figures for the ova of his American specimens are ·084 × ·04 mm., so that they also correspond with other observations.

This parasite is usually confined to the intestine of its host, though occasionally one or two specimens are to be found in the stomach and in one host (*Gadus melanostomus*), according to Olsson, it occurs in the pyloric cæca.

While studying this form, I examined sticklebacks from three different regions, viz. (1) rock-pools, (2) brackish ditches communicating with the sea, (3) streams near their entrance into the sea. In the first two instances I obtained *Gasterosteus aculeatus*, var. *trachurus*; in the third, var. *gymnurus*. The river sticklebacks were much smaller than those from the sea, and in no case did they harbour *Podocotyle atomon*. The specimens from the pools and ditches were identical and were each equally subject to infection.

Levinsen asserts that the intermediate host of *Distomum simplex* is *Themisto libellula*. This crustacean is not recorded from the St. Andrews district, so that it cannot be the intermediate host here.

Lepodora rachiæa, Cobbold *. (Pl. I. figs. 3, 4.)

Distomum rachion, Cobbold, Trans. Linn. Soc. xxii. p. 158, pl. xxxi. figs. 9, 10; Stossich, Dist. d. Pesci, p. 43; Linton, Proc. U.S. Nat. Mus. xx. p. 558, pl. liii. figs. 3–7.

Lepodora rachiæa, Odhner, Fauna Arctica, iv. (2) p. 332, pl. ii. figs. 12–15.

To reconcile Cobbold's figure of *Distomum rachion* with the one which I herewith submit seems at first sight difficult. The disposition of the genital glands and uterus appears to effectually separate them. The resemblance in other respects, however, is striking enough, and as it is possible to interpret correctly the structures misrepresented by Cobbold, I have little doubt that his specimens and mine are identical, and this is endorsed by the facts that the organization of the parasite is definitely characteristic and that *Gadus æglefinus* figures as the host in both instances.

Cobbold's description is embodied in a few lines, but this brevity is remedied by a boldly drawn figure. In interpreting this figure we must suppose either that he drew from the living animal, when the thickness of the body would prevent him seeing clearly the organs in the posterior part, or that his preserved specimens were not sufficiently cleared.

* Odhner's amended descriptions of this species and others did not come to hand until the present paper was in the press.

The anterior region is correct except that the genital aperture is rather far forward and the cuticular spines have assumed enormous proportions. The ventral sucker has a somewhat powerful appearance, and the vesicula seminalis extends as far back as the anterior testis. The testes are correctly enough placed, but the ovary is posterior to them instead of in front. The uterus displays the greatest divergence; it is represented as two tubes, winding down, one on each side of the body, to the extreme posterior end. It is to be presumed that Cobbold here confused the uterus with the vitelline glands, the rounded follicles of which might be mistaken for ova. The uterine walls must have been supplied from imagination.

Cobbold fancies a resemblance between this species and *Distomum scabrum*, Zed., and *D. appendiculatum*, Rud. Wherein this lies I fail to perceive, even in Cobbold's figure, for the organization of the alimentary system with its long pre-pharynx, the presence of the large spines, and the disposition of the entire genital system are widely different from the corresponding structures in the above-mentioned species.

Stossich's description of this form is merely a brief translation of Cobbold's. Along with von Linstow* he falls into the error of attributing it to the cod (*Gadus morrhua*) instead of *Gadus æglefinus*, although Cobbold is perfectly clear on this point.

A not uncommon parasite of the haddock, it occurred in rather more than 50 per cent. of individuals examined, always in the intestine and never in large numbers. It is of moderate size: length 1·88–4·47 mm., maximum breadth ·61–·90 mm.; average size 2·65 × ·69 mm.; body of elongated oval outline, rounded at both ends, somewhat attenuate anteriorly. It is of compact build, sluggish in movement, and does not long survive removal from its host. The cuticle is beset with stout regularly arranged spines covering the whole of the ant-acetabular region and gradually disappearing behind the ventral sucker. A few spines are to be found laterally within a short distance of the tip of the tail. The length of the spines is about ·012 mm., but they are shorter in front and longer posteriorly. They have comparatively broad bases and are arranged so that the spines of each row alternate with those of adjacent rows.

The oral sucker is almost terminal, of fair size (diameter ·24–·38 mm.), but not very muscular. The ventral sucker is remarkably small and feeble; it is situated almost centrally

* Compend. d. Helminthol. 1878, p. 238.

and has a diameter of ·14–·23 mm. Both are circular in outline with circular apertures.

The alimentary system is well developed. The mouth opens into a long pre-pharynx (about ·3 mm. long in an average specimen), which is followed by a pharynx of large size (·21 × ·16 mm.); the œsophagus is very short and the diverticula into which it divides are of great width and extend to the end of the body.

The excretory vesicle is a simple sac of no great extent, in the posterior end of the body and opens by a terminal pore.

The testes are median, one behind the other, in the posterior third of the body. They are globular or ovoid in shape and of considerable size (·25 mm. diameter). The edge of the posterior testis is at a distance of about ·6 mm. from the end of the body. The ovary lies directly in front of the testes and is much smaller than them. The receptaculum seminis is an elongated vesicle lying between the ovary and the anterior testis. The vitelline glands are extensive and well-defined; situated laterally from the level of the ventral sucker to the posterior extremity of the body. They consist of numerous, compact, irregular follicles.

The ova are few in number (about 30) and are confined to the space bounded by the ovary, the ventral sucker, and the two intestinal diverticula. Light yellow in colour, ovoid in shape, they measure ·059–·068 mm. in length and ·033–·040 mm. in breadth.

The genital aperture is in front of the ventral sucker, but to the left of the middle line; it is within the intestinal fork. The sphincter muscle surrounding it is sometimes very prominent.

The penis-sac (Pl. I. fig. 4) is of large size and divided into two portions by a constriction. The anterior part is the penis-sac proper, containing the retracted penis and the prostate, neither of which is very large. This part is regularly ovoid and lies in front of and dorsal to the ventral sucker. Joined to this by a narrow neck is a large sac containing a long rather narrow vesicula seminalis. This sac is capable of considerable extension and contraction, and in the latter state the vesicula seminalis becomes bent up, as is shown in the figure. There is a short non-prostatic part of the ductus ejaculatorius issuing from the anterior end of the seminal vesicle.

Linton describes a form from *Gadus callarias*, which he identifies as *Distomum rachion*, Cobbold, or a species very near it. His description is short, but the measurements he notes for the various organs show a remarkable agreement

with those obtained from my specimens. It deals mainly with the external appearance, and as his figure is poor little exact knowledge of the more important internal organs is to be derived from it. The suckers and alimentary canal are distinctly reproduced, as are also the testes. The penis-sac ("cirrus-pouch") occupies its proper position, but the genital aperture is in the middle line almost directly over the intestinal bifurcation. Two round bodies are figured in front of the testes, but their nature is not noted. From analogy the posterior of the two bodies would represent the ovary, but it is much larger than I am accustomed to see it, and, in fact, is as large as either of the testes. In the same way the anterior body would be the vesicula seminalis, but it is much further behind the ventral sucker than in my specimens. The yolk-glands are not well indicated. A most important feature of difference lies in the arrangement of the spines, which, if Linton's figure is to be depended on, would distinctly differentiate his specimen. He represents them as scales (from the anterior region), in close array, overlapping but not arranged alternately. On no part have I observed such an arrangement; the spines are certainly scale-like on the neck, but they are well spaced and always alternate with those of the next row. Thus, in the absence of more exact information, it is impossible to determine whether Linton's one specimen is *Lepodora rachiæa*, Cobbold, or not, but it is certainly very near it.

Subfamily *Echinostomin.e*, Looss.

Genus Stephanochasmus, Looss.

1899. *Stephanostomum*, Lss. Zool. Jahrb. Syst. xii. p. 576.
1900. *Stephanochasmus*, Lss. Zool. Anz. xxiii. p. 603.

Stephanochasmus baccatus, sp. n. (Pl. II. figs. 5–7.)

Of this species I have been able to obtain only one specimen. It occurred in the rectum of a halibut (*Hippoglossus vulgaris*), and at first sight appeared to correspond so closely with my recollection of *Stephanochasmus cesticillus*, Molin, that I regarded it as such and placed it aside. A note by Looss * on some examples of this latter form, drawing attention to an error or variation in the number and arrangement of the circumoral spines, induced me to re-examine my specimen. Several features of difference at once presented themselves; moreover, comparison with the

* Zool. Jahrb. Syst. xii. p. 696.

other species of the genus did not admit its inclusion with any of them. It thus falls to be described as a new species.

The following description as well as the figure are from the preserved specimen, so that the measurements may admit of modification :—

The body is depressed, elongate-ovate, somewhat attenuate in front, rounded behind, with a small but distinct terminal prominence. Length 3·34 mm.; maximum breadth (at ventral sucker) ·75 mm. Ant-acetabular region (neck) comprises $\frac{1}{4}$ of length of body. Anteriorly the cuticle is beset with numerous irregularly arranged spines, becoming fewer behind the ventral sucker and absent from the greater part of the post-acetabular region. Closely apposed to the margin of the oral sucker are two rows of large spines. The spines in the first row are shorter than those in the second, the lengths being about ·031 mm. and ·037 mm. respectively, but there is some variation. The number and disposition of these spines are characteristic of the species, and serve to distinguish it from other species of the genus. They occur in two regular uninterrupted rows; there are 28 spines in each row, making a total of 56, and the spines of one row alternate with those of the other. In no other species are the spines so numerous, the nearest approximation being 48, as recorded by Looss in *Stephanochasmus caducus*, Lss. *Steph. pristis*, Deslongch., according to Looss, has 36 spines. A point which Looss lays stress on is that in his examples of *Steph. cesticillus* the second row of spines numbers one less than the first. This is due to the absence of a spine of the second row in the mid-ventral line. No such arrangement occurs in *Steph. baccatus*; each row is complete, so that there is no gap in the mid-ventral line. In *Steph. cesticillus*, moreover, the spines of the first row are longer than those of the second. Between the two species another feature of difference presents itself in the disposition of the other cuticular spines. In Looss's figure these do not start immediately behind the cephalic spines, so that a small triangular bare area is left. This does not occur in *Steph. baccatus*, for irregular scattered spines are seen on the neck immediately behind the cephalic spines.

The suckers are comparatively small and not very muscular. The oral sucker is terminal and cup-shaped; its diameter is ·23 mm., while the aperture is ·19 mm. At the lateral margins of the rim, projecting into the aperture, a little nodule is apparent. Whether this is a natural condition or the result of preservation I am unable to say. The ventral sucker is at a distance of ·87 mm. from the anterior

end. It is approximately globular, and has a diameter of ·33 mm. with a circular aperture.

The alimentary system is fairly typical. The prepharynx is shorter than in *Steph. cesticillus*, being only ·17 mm. long. The pharynx is large and almost horseshoe-shaped, with the convexity directed backwards; it measures ·21 × ·16 mm. The œsophagus is extremely short. The diverticula extend to the posterior extremity, and are wide and irregularly dilated. The bifurcation occurs just a little in front of the ventral sucker.

The testes are situated in the posterior third of the body, one behind the other in the middle line. In shape they are ovoid, and have a greatest diameter (longitudinal) of ·38 mm. The ovary lies directly in front, almost median or a little to the right, and is less than the testes (·21 mm.). The vitelline glands are lateral, extending from the posterior end of the body to a short distance behind the ventral sucker; they consist of small compact follicles.

There are very few ova (17), but they are of large size, measuring ·087–·091 mm. × ·044–·053 mm. The shape is unusual, pointed at one end and truncated at the other*. The uterus lies entirely between the ovary and the ventral sucker, and is confined laterally by the intestinal diverticula. There is a long club-shaped penis-sac extending some distance behind the ventral sucker, though not so elongated as in *Steph. cesticillus*. The posterior portion is occupied by a large ovoid vesicula seminalis. There is a considerable pars prostatica. The genital aperture is median, directly in front of the ventral sucker.

It is evident that this species differs very considerably from already known forms. In the first place the body is much less elongated, and the suckers are proportionately further apart and larger. The cephalic spines, besides being more numerous than in any other species, are differently disposed, those in the anterior row being shorter than those

* Three ova were observed lying within the ventral sucker. This recalls a condition already noted (Ann. & Mag. Nat. Hist. (7) xvii. p. 520) in a parasite inhabiting the cloaca of *Larus argentatus*. The supposition which I then hazarded seems to be strengthened by this case. Both are forms living in the terminal portion of the gut of their host, and the possibility suggests itself that in both the ova may be retained for some time within the ventral sucker in order to prevent their being excreted in too immature a condition. Many forms having a similar habitat display adaptations in the ova, having apparently the same end in view. The precocious development of eye-spots in several species and the ciliated embryos in *Distomum viviparum*, Olsson (from the end-gut of Pleuronectid fishes), are illustrative cases.

in the posterior. In *Steph. minutus*, Looss *, they are of equal size in the two rows, but in the other species the anterior row contains the larger spines. In addition the ova are much larger than those of any other species except *Steph. vesticillus*.

Zoogonoides viviparus, Olsson.
(Pl. II. fig. 8 ; Pl. III. fig. 9.)

Distomum viviparum, Olsson, Lunds Univ. Arsskrift, 1867, iv. no. 8, p. 28, pl. iv. figs. 73–75.
Zoogonus viviparus, Looss, Centralbl. Bakt. 1ste Abtheil. xxix. p. 440.
Zoogonoides viviparus, Odhner, Centralbl. Bakt. 1ste Abtheil. xxxi. p. 62, fig. 2.

This species, first discovered by Olsson in *Pleuronectes microcephalus* and incorrectly described by him, has been fully described by Odhner. Looss assigned it to the genus *Zoogonus*, Lss., along with *Z. mirus*, Lss., but Odhner with reason regarded it as the type of a new genus. Olsson was only able to discover two specimens, occurring, as he believed, in the stomach of the host. Odhner, however, correctly points out that the true habitat of the species is the terminal portion of the intestine. He found it in *Pleuronectes flesus*, *Pl. limanda*, *Pl. platessa*, *Pl. microcephalus*, *Hippoglossoides platessoides*, and *Callionymus lyra*. I have found it here in *Pl. limanda*, *Pl. platessa*, and *Rhombus maximus*, and always in the lower reaches of the intestine, particularly the rectum. It always occurs in large numbers, usually accompanied in *Pleuronectes limanda* by *Steringophorus furciger*, Olsson.

Odhner's description of the species is almost exhaustive. The limits of size which he gives, however, are rather narrow. I have found mature examples as small as ·8 mm. and, in *Rhombus maximus*, as large as 1·6 mm. ; in *Pleuronectes limanda* they never exceed 1·2 mm. The maximum breadth is ·31–·42 mm. The diameter of the oral sucker lies within Odhner's limits, viz. ·14–·16 mm. ; but the ventral sucker is never twice as large, as Odhner has it, and its aperture is nearly circular, or if elliptical the eccentricity is small. The cuticular spines are very minute, arranged in a regular diamond pattern, and cover the whole body except a small part at the posterior end. The intestinal diverticula do not extend beyond the posterior border of the ventral sucker.

The testes are two ovoid bodies, situated about the level

* Centralbl. für Bakter. 1ste Abtheil. xxix. p. 604, figs. 5, 5 *a*.

of the posterior border of the ventral sucker and symmetrically placed, one on either side of this. In the living specimen it is difficult to fix the exact position of the testes and ovary, for they move backwards and forwards with the movements of the animal. Sometimes one testis is a little further forward than the other, and sometimes the ovary is on a level with one or both. In preserved specimens the position is pretty much as shown in the figure (Pl. II. fig. 8, *T*). The ovary is to the rear of the ventral sucker, almost median or somewhat to the right. It is smaller and more globular than the testes. I find the size of the miracidium-containing capsule to be ·086–·094 × ·042–·044 mm., which is larger than Odhner has it.

Subfam. *Hemiurinæ* (Looss, ex p.), Lühe.

Looss * included in this subfamily the appendiculate Distomes and their congeners. Lühe †, however, saw fit to restrict the name to a certain group of these forms represented by two genera, *Hemiurus*, Rud. (ex p.), and *Lecithocladium*, n. g. Odhner later ‡ removed *Hemiurus crenatus*, Rud., from the former genus and made it the type of a distinct genus, *Brachyphallus*. Of the members of this subfamily we have here to deal with *Hemiurus appendiculatus*, Rud., and *Brachyphallus crenatus*, Rud.

Genus Hemiurus, Rud. (ex p.), Lühe.

Within this genus Lühe includes only *H. appendiculatus* (Rud., 1802), *H. Stossichii* (Montic., 1891), *H. crenatus*, Rud., 1802 (= *Distomum ocreatum*, Olsson, 1867), *H. lævis*, Linton, and *H. grandiporus*, Molin. These all agree in having the yolk-glands compact, rounded or only slightly lobed, situated close behind the ovary and almost touching each other. The features in which they present differences are, amongst others, the relative sizes of the suckers, the proportionate length of the appendix, the position of the genital aperture, the length of the pars prostatica, and the position of the vesicula seminalis.

I have had before me during my investigation specimens of appendiculate Distomes belonging to the genus *Hemiurus* from four different hosts:—*Clupea harengus*, *Hippoglossus*

* Zool. Jahrb. Syst. xii. p. 640.
† Zool. Anzeig. xxiv. p. 394.
‡ Fauna Arctica, iv. (2) pp. 352, 353.

vulgaris, *Gadus æglefinus*, and *Ammodytes tobianus*. From the first three *Distomum appendiculatum*, Rud., has already been recorded, but, as Lühe points out, identification has in many cases been totally erroneous. Each of the four varieties which I have examined agree well enough on superficial inspection with the accepted idea of *Distomum appendiculatum*, Rud., but on closer investigation they are found to differ each from the other to a greater or less degree and all from Lühe's amended definition * of *Heminrus appendiculatus*, Rud.; they approach more nearly to *H. Stossichii* (Montic.), Lühe †. The chief features of difference between the above-mentioned varieties are the situation of the testes and the length of the pars prostatica and consequent position of the seminal vesicle. In these respects the examples from the haddock, sand-eel, and halibut agree closely with each other and differ markedly from the herring specimens. We must therefore regard the former as distinct from the latter. To fully reconcile either with already existing descriptions and in particular with the definitions of Lühe is impossible. For the present, however, I shall include the specimens from *Clupea harengus* under *Hemiurus Lühei*, Odhner, while those from *Ammodytes tobianus* are noticed under *Hemiurus communis*, Odhner.

Hemiurus Lühei, Odhner [=*H. Stossichii* (Montic.), Lühe].

From the stomach and cæcum of *Clupea harengus*.

The already recorded host of this form is *Clupea pilchardus*, and the fact that this fish is a member of the same family as the herring strengthens the probability that the forms from both are identical. Without attempting a full description of the species I shall endeavour to make clear wherein my specimens differ from Lühe's definition.

Its occurrence in the herring was frequent and in great numbers, and it was the only intestinal parasite to be met with. The body is very much elongated. The length, including the extended appendix, is 2·70–4·14 mm. Of this the appendix comprises about $\frac{1}{3}$–$\frac{1}{4}$ (*i. e.* the appendix = $\frac{1}{4}$–$\frac{1}{3}$ of the rest of the body). The breadth was measured at two points, (1) just behind the ventral suckers, (2) immediately in front of the appendix ; it was found remarkably constant, viz. ·28–·33 mm. × ·35–·40 mm., representing a somewhat more attenuate condition than Lühe admits in *H. Stossichii*. The length of the neck (taken as the distance between the

* Zool. Anzeig. xxiv. p. 396. † *Ibid.* p. 398.

centres of the two suckers) has also a fairly constant proportion. It was ·33–·40 mm., representing a proportion of $\frac{1}{5}$–$\frac{1}{6}$ of the body (without appendix). The oral sucker has a diameter of ·11–·13 mm. and the ventral ·18–·24 mm. The relative proportion may therefore be approximately 1 : 2 or 2 : 3, not invariably 2 : 3 as Lühe has it. The pharynx is contiguous with the oral sucker and has a length of ·06 mm. with a breadth of ·06–·07 mm. The œsophagus is very short or absent. The intestinal diverticula may extend into the appendix, but usually do not. The cuticle of the body is ringed ("geringelt"), that of the appendix is deeply striated.

The genital aperture lies a short distance behind the ventral lip of the oral sucker; the genital sinus is long and extends almost as far back as the ventral sucker. The pars prostatica is also of great length; the prostate cells are very numerous and form a dense mass behind the ventral sucker. In consequence of the length of the prostate, the vesicula seminalis is at a great distance behind the ventral sucker. The distance as measured is from ·6 mm. to ·9 mm., *i. e.* rather more than $\frac{1}{4}$ of the body-length. The seminal vesicle is double and usually lies towards the left side. The testes are just behind it and one is almost directly behind the other, the obliquity being very slight. They are globular or somewhat ovoid and of fair size (diam. ·14–·16 mm.). The ovary and vitelline glands lie almost midway between the testes and the beginning of the appendix. The ovary is always elliptical, the long axis being transverse, and measures ·13–·18 × ·11–·12 mm. It is thus about the same size as the testes. The yolk-glands lie close behind and ventral to the ovary, and are each about the same size as the ovary; they are slightly lobed, one usually having three, the other four lobes. This coincides, curiously enough, with Lühe's observations in the cases where the yolk-glands are tubular. The glands are at a distance of ·4–·6 mm. from the appendix. The uterus is very voluminous and may extend a short distance into the appendix, but usually does not. The ova are numerous and measure ·022–·028 mm. × ·011–·012 mm.

Hemiurus communis, Odhner.

From the œsophagus, stomach, and intestine of *Ammodytes tobianus* and from the stomach of *Gadus æglefinus*.

This species shows very great resemblance both to *H. appendiculatus* and to *H. Lühei*. It is differentiated from the former by the situation of the testes, which are close

behind the ventral sucker and markedly oblique; also by the relative sizes of the suckers. From *H. Luhei* it differs in the length of the œsophagus, in the shortness of the pars prostatica, and in the forward position of the vesicula seminalis and testes. It differs from both in the length of the appendix.

Mature examples were found in the sand-eel, varying in length (including appendix) from 1·5–2·5 mm. Of this the appendix often comprised as much as $\frac{2}{3}$ (*i. e.* $\frac{2}{3}$ of the rest of the body); usually somewhat smaller, but never less than half as long as the rest of the body. The examples from the haddock and the halibut agree in this respect. The body is not so attenuated as in the form from *Clupea harengus*, the breadth being ·37–·38 mm. just behind the ventral sucker and ·42–·57 in front of the appendix. The neck (distance between centres of suckers) is also much longer than in the above form, being $\frac{1}{3}$ of the body-length. The oral sucker has a diameter of ·11–·18 mm. and the ventral a diameter of ·16–·26 mm., so that the relative size is from $\frac{1}{2}$ to $\frac{2}{3}$, more usually the latter. The pharynx is contiguous with the oral sucker and measures ·06 × ·07. There is a distinct œsophagus, about as long as or longer than the pharynx. The intestinal diverticula may extend a considerable distance into the appendix, but often stop short of it. The cuticle of the body is ringed, but the rings become faint towards the appendix. The striations on the latter are not very distinct. It is usually divided into two portions of almost equal length, the posterior of which becomes invaginated within the other when the appendix is retracted.

The genital aperture occupies the same position as in the preceding species; the genital sinus is not quite so long. The pars prostatica is shorter and the seminal vesicle, which is double, is immediately behind the ventral sucker. The testes are globular or ovoid and are not far behind the seminal vesicle; somewhat obliquely situated, the left is almost entirely in front of the right. They have a diameter of ·10–·16 mm. The ovary is ovoid, the long axis being transverse, and measures ·11–·16 mm. × ·09 mm. The yolk-glands are behind the ovary and contiguous with it; they are usually slightly lobed as in the preceding species. The uterus is voluminous and may extend into the appendix. The ova are numerous and measure ·022–·031 mm. × ·009–·013 mm.

The specimens from *Gadus æglefinus* present slight variations from the above and tend more to *H. appendiculatus*, but they certainly cannot be included under that species according to Lühe's definition.

An interesting occurrence was witnessed while a living specimen from the sand-eel was being examined. The left yolk-gland was observed to gradually, but rapidly disappear, so that not a trace was left. The preserved specimen exhibits only one yolk-gland. This may afford a possible explanation of Monticelli's observation of only one gland in *Hemiurus Stossichii*, a case which Lühe has difficulty in reconciling with his own observations *.

In an example of *Hemiurus appendiculatus* from the halibut (Pl. III. fig. 11) a rare condition was met with, namely, pigment-spots in the ova. The presence of eye-spots in the ova of Hemiurinæ is not usual, and on that account I regarded the case as suspicious. On close examination some of the ova displayed two spots, one at each pole; others had several spots congregated at one end, but in the majority the appearance simulated the usual occurrence of eye-spots. Indications of pigmentation, however, were found throughout the body and large patches were discovered in the substance of both suckers. Another smaller example showed no spots in the ova, but the suckers contained several black patches. The explanation of this seems difficult; the case is certainly unique in my experience, and I can only attribute it at present to some diseased condition.

Brachyphallus crenatus (Rud.), Lühe.

Distoma crenatum, Rud. Entoz. Hist. ii. p. 404, pl. v. fig. 1.

Distoma ocreatum, Olsson, Lunds Univ. Årsskrift, iv. (8) p. 48, pl. v. figs. 96–98.

Hemiurus crenatus, Lühe, Zool. Anzeig. xxiv. p. 399; Lander, Bull. Mus. Harvard, xlv. no. 1.

Brachyphallus crenatus, Odhner, Fauna Arctica, iv. (2) p. 352.

Amongst the numerous examples of *Hemiurus communis* from the sand-eel several specimens of this species were found. It is at once differentiated by the almost equal size of the suckers. The length of my examples, which were pretty nearly all of one size, was 2·12–2·38 mm., with an appendix of 1·08–1·18 mm., *i. e.* the appendix equals about half the length of the rest of the body. This corresponds very well with the observations of Lander and Odhner. Lühe makes the length 1·25–1·35 mm. and the appendix $\frac{3}{4}$ as long as the trunk. The breadth behind the ventral sucker was ·52–·64 mm., and near the appendix it was ·71–·77 mm. These figures are much in excess of any found by other observers.

* Zool. Anzeiger, xxiv. p. 399, note 13.

The diameter of the oral sucker was ·24–·26 mm., that of the ventral sucker ·28–·30 mm., the proportion therefore being 6 : 7, which is identical with that found by Lander and Odhner. The genital aperture lies midway between the suckers: Lander says nearer the oral sucker, Odhner nearer the ventral. The appendix always appears in two parts and the intestinal diverticula reach to nearly its extreme end. It is deeply striated.

The pharynx is contiguous with the oral sucker. Between the observations of the above observers there is some divergence, Odhner's dimensions being much less than those of Lander. I have found it to vary, the breadth as often as not exceeding the length. Length ·09–·12 mm., diameter ·09–·11 mm. These figures agree more with Lander's. In my specimen the left testis is further forward than the right, which disagrees with both Odhner and Lander's figures. The ovary is globular or ovoid and smaller than the testes. The yolk-glands are usually compact, but sometimes they are more or less scattered, a part being occasionally found at some distance from the main mass and connected with it by a narrower portion. In one case single follicles were observed scattered throughout the body near the appendix. The ova measure ·021–·023 mm. × ·015–·016 mm.; they are thus somewhat broader than those measured by Odhner.

Subfamily *Lecithochiriinæ*, Lühe.

Genus Lecithaster, Lühe.

Lecithaster gibbosus, Rud. [=*L. mollissimus*, Levinsen].

From a sand-eel (*Ammodytes tobianus*) I obtained what I believe to be a specimen of this parasite. It occurred only once, although more than fifty sand-eels were examined, so that it is extremely rare. It was, unfortunately, damaged during inspection, but not before I had observed the following particulars :—

A large vesicula seminalis lay at the level of the ventral sucker and dorsal to it. A ductus ejaculatorius, with prostatic cells, stretched forward to open a little way behind the oral sucker. In the posterior part of the body the yolk-glands were arranged in seven or eight lobes radiating from a common centre. There was a small caudal appendix. In the position of the testes were situated two circular bodies, displaying internally a system of concentric rings. For this appearance I am unable to account. The ovary could not be

distinguished, and there were no ova (so that the specimen was probably immature). Together with the size of the body and the condition of the suckers these characters seem sufficient to establish identity with *Distomum mollissimum* as described by Levinsen *.

Genus Derogenes, Lühe.

Derogenes varicus, Müller.

This has proved one of the most widely distributed Trematodes in this locality, and has occurred in the following hosts:—*Gadus merlangus* (intestine), *Hippoglossus vulgaris* (stomach), *Rhombus maximus* (oral cavity, œsophagus, and stomach), *Rhombus lævis* (stomach), *Pleuronectes limanda* (oral cavity, œsophagus, and stomach), and *Cottus scorpius* (intestine). It is here recorded for the first time from *Rhombus maximus* and *Pleuronectes limanda*, and in these it has occurred most frequently.

Its characters are so well known that it calls for no description here. The limits of size are wide, Stossich giving them as 1·5–7 mm. I have found adult specimens less than 1 mm. long, and the largest example obtained was 3·4 mm. long from the stomach of the turbot. The most common size is 1·5–2·0 mm. The oral sucker in individuals of that size has a diameter of ·19–·24 mm., and the ventral sucker ·33–·40 mm. The ova vary greatly in specimens from different hosts. The limits in length are ·050–·062 mm., and in breadth ·025–·034 mm. Those in front of the ventral sucker are always larger than those behind, and it is in the latter that the greatest variations are to be observed. Thus in an example from the halibut the ova in the anterior part of the body measured ·059 × ·032 mm., in the posterior part ·057 × ·027 mm. The approximate size of the ova just about to be extruded may be taken as ·056–·060 × ·031–·034 mm.

Derogenes cacozelus, sp. n. (Pl. III. fig. 10.)

Found in the intestine and rectum of *Hippoglossus vulgaris* and the intestine of *Pleuronectes limanda*. It is not at all common, only a few specimens having been obtained. It bears a close resemblance to *Derogenes varicus*, Müller, but the large vesicula seminalis and the small ova differentiate it at once from that species.

The body is elongated, cylindrical, broadest in the middle,

* Oversigt Kgl. Dansk. Selskab. 1881, pp. 59–61, pl. ii. fig. 4.

tapering towards each end. Length ·87–1·51 mm. The section is approximately circular. The cuticle is unarmed, but very faint transverse wrinkles appear on the surface. The oral sucker is subterminal, globular, with a diameter of ·16 mm. (in a specimen of length 1·5 mm.). The ventral sucker is somewhat prominent, globular, and lies in front of the middle of the body (·57 mm. from anterior end); its diameter is ·23 mm. Both have circular apertures.

There is a large muscular pharynx, almost globular, with a diameter of ·08 mm. The œsophagus is extremely short and the intestinal bifurcation takes place immediately behind the pharynx. The diverticula are wide, irregularly dilated, and extend to the posterior extremity of the body. The excretory system resembles that of *Derogenes varicus*.

The testes are obliquely placed behind the ventral sucker; they are two ovoid bodies, with a maximum diameter of ·12 mm. The ovary is more nearly globular: diameter ·10 mm. It is situated almost midway between the ventral sucker and the tip of the tail. Behind it lies a pair of large vitelline glands having the same structure and disposition as in *Derogenes varicus*. The uterus is much convoluted and fills a large portion of the body. The eggs are very numerous and rather small, ovoid in shape. Size ·021–·023 mm. × ·014–·016 mm.

There is a large ovoid vesicula seminalis lying on the same level as the ventral sucker and dorsal to it, measuring ·23 × ·17 mm. From it issues a somewhat narrow ductus ejaculatorius, leading forward to the penis-sac. The duct is surrounded for two thirds of its length by numerous prostate-gland cells lying free in the body-substance. The penis-sac resembles that in *Derogenes varicus*. It is somewhat pear-shaped or almost globular. The aperture is situated in the mid-ventral line at a distance of ·21 mm. from the edge of the oral sucker.

Distomum sp. (Pl. III. fig. 12; Pl. IV. fig. 13.)

From the muscles &c. of *Cottus bubalis*.

While collecting one day I observed a *Cottus* lying in a small rock-pool. I approached it cautiously, but it seemed unaware of my presence until I seized it, and even then its struggles to escape were feeble. In a tank it took no notice of food or objects placed near it, but lay torpid. It appeared to be blind. On dissection the cause was revealed. The whole body, skin, muscles, bones, and the layers of the eye were impregnated with small masses of black pigment,

accompanied by cysts containing Trematode cercariæ. The only parts not affected were the brain and the abdominal organs. The pigment-spots appeared to follow the course of the blood-vessels, as is evident from fig. 13, and they are probably spread throughout the body by means of the blood. The nature of the pigment I did not ascertain. The Trematode is a small tailless larva, having the body entirely covered with minute spines, two small suckers, and with intestinal diverticula extending to the tip of the tail. I am at present unable to assign it to any known species.

This occurrence may admit of explanation in the same way as Johnstone * accounts for a similar infection of *Pleuronectes limanda*, although the parasites in the two cases are not identical.

Distomum sp.

From gills of *Cottus scorpius* and *Gobius Ruthensparri* in capsules.

This occurred rarely, but in infected specimens the numbers were large. The wall of the cyst was thin, so that the enclosed larva could be easily seen. It possessed few distinctive features, so that identification was, for the time being, impossible.

Nematoda.

Ascaropsis morrhuæ, van Beneden. (Pl. IV. figs. 14–16.)

Ascaropsis morrhuæ, van Beneden, Mém. Acad. Belg. 1871, xxxviii. p. 56, pl. iii. fig. 11.

Van Beneden appears to have instituted this genus and species at one and the same time, but he gives no definition of the genus or description of the species except a few words in a footnote and drawings of the head, tail, and ovum. From these, however, I am able to establish the identity of the specimens which I assign to this species.

Van Beneden found it in the intestine and pyloric cæca of the cod (*Gadus morrhua*). I have to record it from *Gadus æglefinus*, *Hippoglossus vulgaris*, and *Cottus bubalis*. In each of the two latter only one specimen occurred, but in the haddock it was extremely numerous and was met with throughout the whole anterior part of the alimentary canal.

The body is elongated, narrow, and cylindrical, of almost uniform girth; attenuated anteriorly and posteriorly, with a

* Report Lancashire Sea-Fisheries Laboratory for 1904, p. 101.

ventral excavation at the tail. Length 6–8 mm., breadth ·8–·9 mm. Cuticle annulated by furrows, which are continuous for more than one annulus. Van Beneden represents each ring as complete, probably owing to his not having studied the character of the annulation. Towards the anterior end the furrows become faint and disappear. Projecting forward from the head are two small spines, omitted by van Beneden; these are largest in the example from *Cottus bubalis*, and almost invisible in that from the halibut.

The mouth is terminal and appears to consist of two equal-sized but little-differentiated lips. There is a long œsophagus and a long simple intestine pursuing an uneven course towards the anus, which opens in the excavation at the tail. In adult specimens the ovary and uterus occupy almost the whole of the remainder of the body. The ovary arises at the posterior extremity of the body and passes forward, twisting round the intestine in its course. The middle third of the body is usually completely filled with ova. These have the characteristic shape, with the two flagella at one pole, noted by van Beneden. Size ·039–·040 mm. × ·021–·022 mm. These measurements are almost uniform in the specimens from each of the three hosts.

A form somewhat resembling this was taken from the intestine of *Pleuronectes microcephalus*. It displayed the characteristic annulation, but on the head, instead of two spines, appeared two prominent circular marks. No ova or genitalia were present, so that the specimen was immature and identification was impossible.

EXPLANATION OF THE PLATES.

The following letters apply to all the figures :—

BSN. Ventral sucker.
CB. Penis-sac.
DE. Ductus ejaculatorius.
DSt. Vitelline glands.
Ex. Excretory vesicle.
I. Intestinal diverticula.
KSt. Ovary.
LC. Laurer's canal.
MSN. Oral sucker.
Oe. Œsophagus.
Ov. Ova.
P. Penis.
PG. Genital aperture.
Ph Pharynx.
PPh. Prepharynx.
PPr. Pars prostatica.
Pr. Prostate glands.
T_1, T_2. Testes.
RS. Receptaculum seminis.
SD Shell-gland.
Ut. Uterus.
Vg. Vagina.
VS. Vesicula seminalis.

Plate I.

Fig. 1. *Podocotyle atomon*, Rud. Anterior part, to show prepharynx; dorsal view.

Fig. 2. *Podocotyle atomon*, Rud. Shell-gland complex; ventral view. *DG*, yolk-duct; *YR*, yolk-receptacle; *KG*, oviduct.
Fig. 3. *Leptodora rachiæa*, Cobbold. Ventral aspect.
Fig. 4. Ditto. Male genital apparatus; penis retracted; dorsal view.

PLATE II.

Fig. 5. *Stephanochasmus baccatus*, sp. n. Ventral aspect.
Fig. 6. Ditto. Head, showing spines; ventral aspect.
Fig. 7. Ditto. Outline of ovum.
Fig. 8. *Zoogonoides viviparus*, Olsson. Ventral aspect. *Em*, embryo.

PLATE III.

Fig. 9. *Zoogonoides viviparus*. Olsson. Penis-sac; penis retracted, showing the spines; ventral view.
Fig. 10. *Derogenes cacozelus*, sp. n. Right lateral aspect.
Fig. 11. *Hemiurus appendiculatus*, Rud., from *Hippoglossus vulgaris*. Loop of uterus, showing ova with pigment-spots.
Fig. 12. Head of *Cottus bubalis*, Euphr. Eye removed, to show pigment-spots in the eye-socket.

PLATE IV.

Fig. 13. Head of *Cottus bubalis*, Euphr. Lower jaw divided and turned to the sides; gills bent back, to show the pigment-spots in the roof of the mouth, following the course of the blood-vessels.
Fig. 14. *Ascaropsis morrhuæ*, van Ben., from *Gadus æglefinus*. *a*, cephalic spines; *b*, termination of annulating furrow; *c*, end of œsophagus; *d*, ova.
Fig. 15. *Ascaropsis morrhuæ*, van Ben., from *Cottus bubalis*. Highly enlarged view of head, showing the two spines.
Fig. 16. Ditto. Tail; ventral aspect. *Int*, intestine; *An*, anus.

The drawings, with the exceptions of figs. 2, 4, 8, 9, were made from preserved specimens.

VIII.—*Descriptions of Fifteen Terrestrial Mollusca from South Africa.* By JAMES COSMO MELVILL, M.A., F.L.S., and JOHN HENRY PONSONBY, F.Z.S.

[Plate VI.]

THREE years having now elapsed since our last communication *, we now venture to offer an eighteenth contribution upon the subject, mainly consisting of the descriptions of seven *Enneæ* and several Helicoids, mostly collected by Miss Hickey, Messrs. J. McBean, J. Farquhar, and H. C. Burnup, to whom our best acknowledgments are due, while we would

* Ann. & Mag. Nat. Hist. ser. 7, vol. xii. (December 1903), pp. 505 *sqq.*